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SOUTH BEND WATER WORKS

WATER-RESOURCES INVESTIGATIONS REPORT 98-4139
Water-quality characteristics-SHEET 2 of 3
Fowler, K.K., and Arihood, L.D., 1998, Geohydrology and quality of ground water in unconsolidated aquifers near South Bend, Indiana

WATER-QUALITY CHARACTERISTICS

GROUND-WATER QUALITY

Ground water is the primary source of drinking water in St. Joseph County, Indiana. The water is withdrawn mainly from sand and gravel aquifers. These aquifers are susceptible to contamination, and numerous potential ground-water-contamination sites have been identified in the study area (Michiana Area Council of Governments, 1991). Increased withdrawals to meet future demands could change flow paths and potentially draw contaminated water into domestic and municipal wells. The maps on this sheet show values for selected water-quality characteristics in the upper and lower aquifers. The approximate location of wells with available water-quality data is indicated by the position of the values on the map. More precise well locations are shown on sheet 3.

A statistical summary of the selected water-quality-property values and constituent concentrations of the upper and lower aquifers is shown in table 1. When a single well was sampled more than once, only the value for the most recent sample was used in the statistical analysis; however, all sample values are shown on the maps. Except in the case of manganese, the results of Wilcoxon-Mann-Whitney rank sum tests (Helsel and Hirsch, 1992) indicate no significant difference at the 95-percent confidence level between the water-quality-property values in the upper and lower aquifers.

Sources of Information

Most of this water-quality information was obtained from the USGS data base and previously published USGS reports. An additional source of information was the Indiana Department of Natural Resources River Basin reports, specifically those for the Kankakee River Basin (Beaty, 1990) and the St. Joseph River Basin (Clendenon and Beaty, 1987). Water samples for many of the municipal wells in St. Joseph County were collected and analyzed by private laboratories; these data were included if sufficient sampling information was available.

Water-Quality Properties and Constituents

Data for two properties (specific conductance and pH) and six constituents (total dissolved solids, hardness as calcium carbonate, manganese, sodium, nitrate, and iron) of water sampled at wells in the study area are shown in figures 9 through 16. The U.S. Environmental Protection Agency (USEPA) has established primary and secondary drinking-water standards for many constituents found in public water systems. The Maximum Contaminant Level (MCL) refers to the maximum permissible level of a contaminant in water. Secondary Maximum Contamination Levels (SMCL's) are federal guidelines regarding taste, odor, color, and certain non-aesthetic effects of drinking water (U. S. Environmental Protection Agency, 1996).

Specific conductance is related to concentration of dissolved solids in natural water and indicates relative amounts of mineralization of the water. Specific conductance values in water from the upper aquifer range from 202 to 1,315 microsiemens per centimeter (µS/cm) at 25 degrees Celsius (°C) (fig. 9). Values for water from the lower aquifer range from 319 to 931 µS/cm at 25°C. The median value is 573 µS/cm in the upper aquifer and 464 µS/cm in the lower aquifer.

The **pH** of water from both aquifers generally ranges from near neutral to slightly alkaline (greater than 7.0 standard units). The pH of water in the upper aquifer ranges from 6.9 to 8.1; pH values in the lower aquifer range from 6.6 to 8.8 (fig. 10). Median values of pH are 7.5 in the upper aquifer and 7.7 in the lower aquifer. For drinking water, the USEPA recommends pH in the range of 6.5 to 8.5 (U.S. Environmental Protection Agency, 1996).

Concentrations of **total dissolved solids** in water from the upper aquifer range from 174 to 860 milligrams per liter (mg/L), with a median value of 361 mg/L (fig. 11). The values for dissolved solids in the lower aquifer water range from 207 to 936 mg/L, with the median value of 430 mg/L. An increase in dissolved solids can occur as water moves deeper into an aquifer and gains dissolved constituents. The SMCL for concentration of dissolved solids is 500 mg/L (U.S. Environmental Protection Agency, 1996).

Ground water in the study area is generally hard to very hard (greater than 180 mg/L as calcium carbonate, $CaCO_3$). **Hardness** concentrations in water in the upper aquifer range from 32 to 816 mg/L with a median value of 278 mg/L (fig. 12). In the lower aquifer, water hardness concentrations range from 4 to 648 mg/L, with a median value of 284 mg/L. Ground water in the study area contains large amounts of calcium and magnesium, the major constituents affecting hardness (Clendenon and Beaty, 1987).

Manganese is an undesirable constituent in water supplies because of its tendency to deposit black oxide stains (Hem, 1985). The few manganese values available for ground water in the study area range from less than 1 microgram per liter (< 1 µg/L) to 780 µg/L in the upper aquifer and from <1 µg/L to 210 µg/L in the lower aquifer (fig. 13). Median values of manganese concentrations in water are significantly greater in the lower aquifer than in the upper aquifer. Although manganese is not known to be harmful to human health, many of the manganese values exceed the SMCL of 50 µg/L (U.S. Environmental Protection Agency, 1996).

Sodium, though not regulated by the USEPA, can have adverse effects on some people. Sodium values in water from the upper aquifer range from 2.6 mg/L to 140 mg/L (fig. 14); sodium values in the lower aquifer range from 1.6 mg/L to 91.1 mg/L. The median values are 10 mg/L in the upper aquifer and 9.3 mg/L in the lower aquifer.

Nitrate in ground water originates from the atmosphere, decaying organisms, and from the application of some fertilizers. High concentrations of nitrate can result from industrial leachate or animal wastes when these contaminants migrate from surface runoff through the unconsolidated deposits to the ground water. The MCL of 10 mg/L as N (U.S. Environmental Protection Agency, 1996) was exceeded in two water samples, each in the upper aquifer. Nitrate concentrations range from a low of < 0.02 mg/L in both aquifers to 12.0 mg/L in the upper aquifer and 7.1 mg/L in the lower aquifer (fig. 15). The median nitrate concentration is 2.1 mg/L in the upper aquifer and 0.1 mg/L in the lower aquifer.

Iron in drinking water can cause discoloration of plumbing fixtures, staining of laundry, and taste problems; however, iron is not generally considered harmful to human health. Total iron concentrations in water from the upper aquifer range from <100 µg/L to 4,700 µg/L, with a median value of 100 µg/L (fig. 16). In the lower aquifer, iron concentrations range from <100 µg/L to 7,500 µg/L, with a median concentration of 200 µg/L. Values greater than 300 µg/L exceed the SMCL (U.S. Environmental Protection Agency, 1996).

Table 1. Statistical summary of general water-quality data and results of Wilcoxon-Mann-Whitney rank sum tests to determine differences in selected constituents between the upper and lower aquifers, St. Joseph County and the eastern part of La Porte County, Indiana

[µS/cm at 25°C, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; µg/L, micrograms per liter; <, less than; p, the probability that an observed difference is due to chance rather than depth; *, significant difference (p<0.05)]

Property or constituent	Aquifer	Number of samples	Minimum	Maximum	25th percentile	Median	75th percentile	Level of significance (p) between aquifers
Specific conductance, µS/cm at 25°C	Upper	24	202	1,315	442	573	680	0.164
	Lower	28	319	882	412	464	558	
pH, standard units	Upper	34	6.9	8.1	7.3	7.5	7.7	.057
	Lower	64	6.6	8.8	7.4	7.7	7.9	
Total dissolved solids, mg/L	Upper	37	174	860	309	361	484	.129
	Lower	65	207	936	318	430	526	
Hardness, mg/L as $CaCO_3$	Upper	164	32	816	228	278	324	.552
	Lower	320	4	648	248	284	328	
Manganese, µg/L	Upper	19	<1	780	<1	4	180	.044*
	Lower	17	<1	210	65	100	140	
Sodium, mg/L	Upper	33	2.6	140	4.6	10	21.5	1.0
	Lower	63	1.6	91.1	4.4	9.3	15.0	
Nitrate, mg/L as N	Upper	30	< .02	12.0	<.02	2.1	4.2	.075
	Lower	48	< .02	7.1	<.02	.1	1.68	
Iron, total, µg/L	Upper	125	<100	4,700	100	100	500	.723
	Lower	245	<100	7,500	100	200	700	

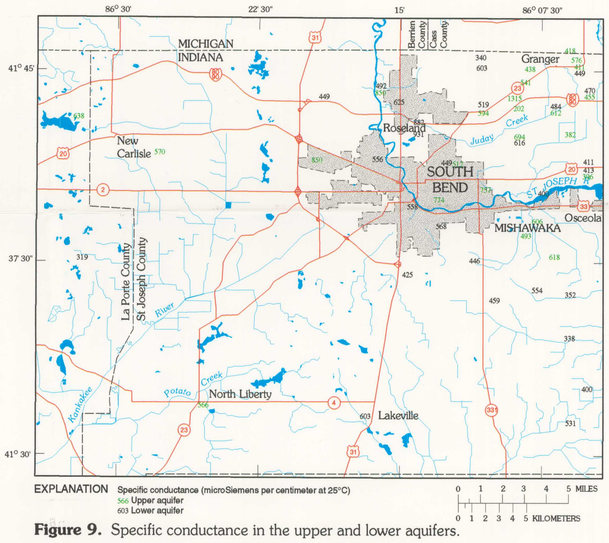

Figure 9. Specific conductance in the upper and lower aquifers.

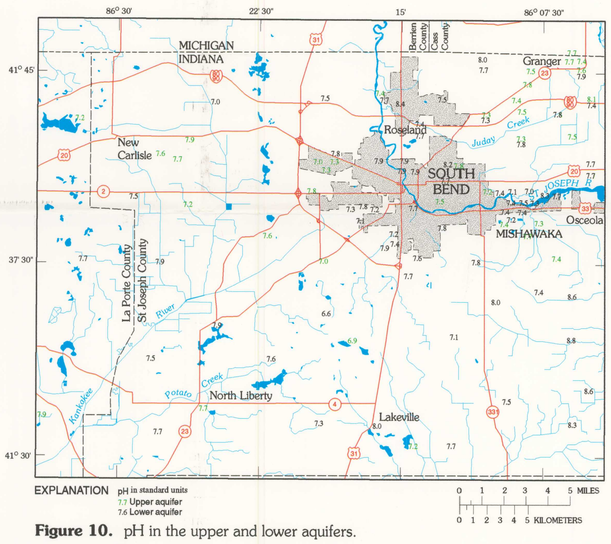

Figure 10. pH in the upper and lower aquifers.

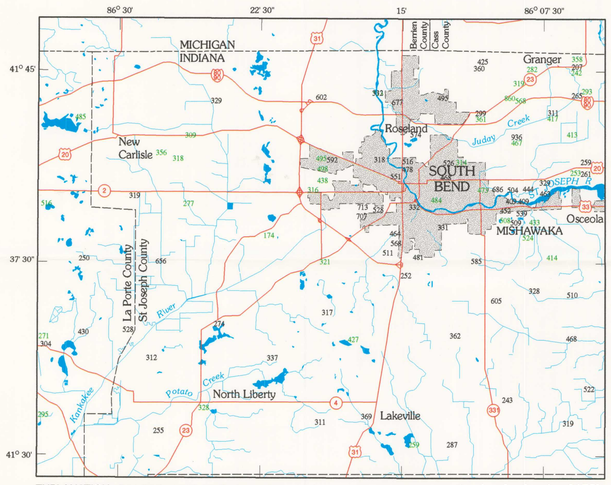

Figure 11. Total dissolved solids in the upper and lower aquifers.

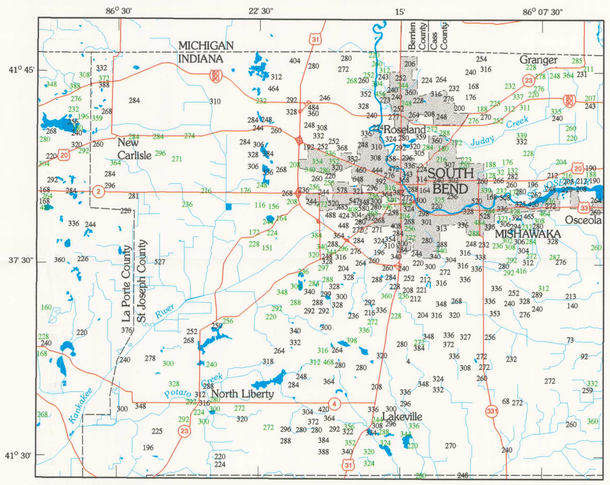

Figure 12. Hardness in the upper and lower aquifers.

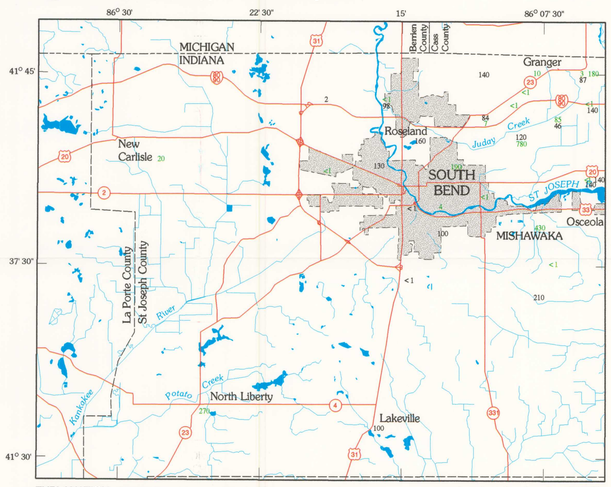

Figure 13. Concentrations of manganese in the upper and lower aquifers.

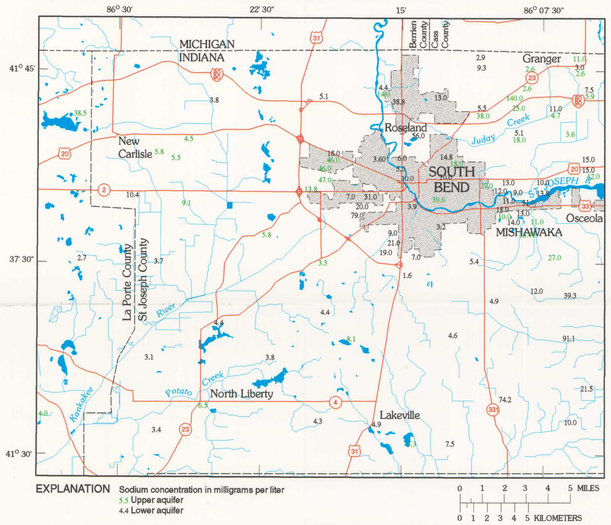

Figure 14. Concentrations of sodium in the upper and lower aquifers.

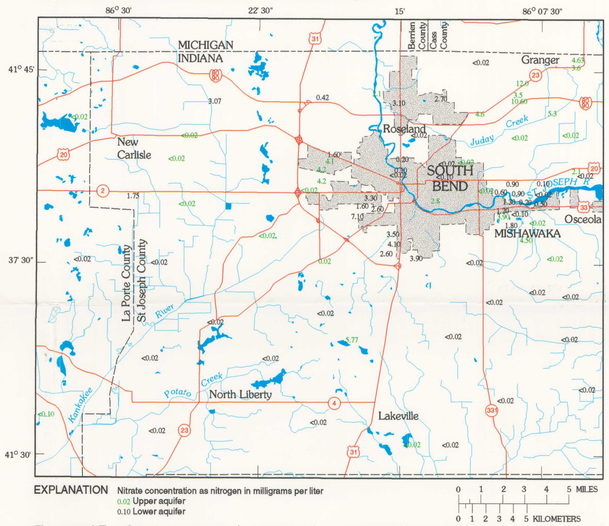

Figure 15. Concentrations of nitrate in the upper and lower aquifers.

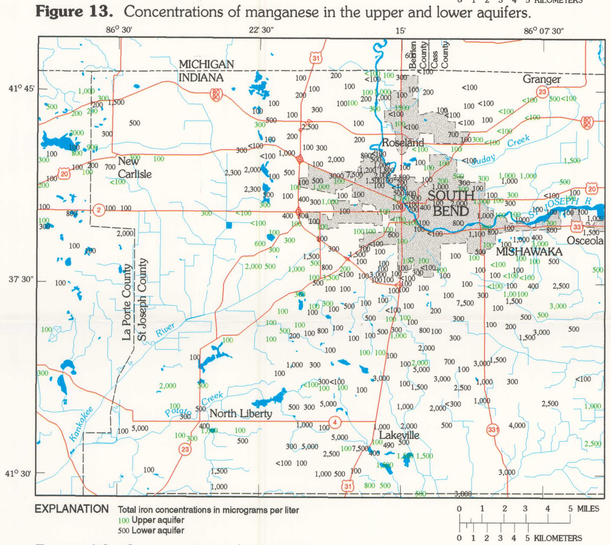

Figure 16. Concentrations of iron in the upper and lower aquifers.

Base maps from U.S. Geological Survey digital data, 1:100,000 1983
Albers Equal Area projection
Standard parallels 29° 30' and 45° 30', central meridian -86°

GEOHYDROLOGY AND QUALITY OF GROUND WATER IN UNCONSOLIDATED AQUIFERS NEAR SOUTH BEND, INDIANA

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